Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of Wireless Bureau and OET Seek Comment On Progeny's M-LMS Field Testing Report	))))	 DA 12-209 WT Docket No 11-49

To: Office of the Secretary
Attn: Chief, Wireless Telecommunications Bureau
Attn: Chief, Office of Engineering and Technology

Reply Comments on the Progeny Test Report

The undersigned entities ("SkyTel")[1] hereby timely submits a reply to comments by parties ("Comments") submitted in the above captioned proceeding on the Progeny test and test report ("Test" and "Test Report") referenced in DA 12-209, on invitation by the Chiefs of the WTB and OET ("Reply Comments").

Attached Technical Review

Attached hereto (separately uploaded on ECFS) as the "Attachment" are technical reply comments by Nishith D. Tripathi, Ph.D. This Attachment referenced and incorporated in full herein as Comments of SkyTel. The Attachment report is the work product and opinion of Dr. Tripathi. (This attached report, with the initial report of Dr. Tripathi attached to the SkyTel Comments on the Progeny Test and Test Report, are herein together called the "Two Tripathi Reports.")

The remaining Reply Comments of SkyTel herein are in accord with and complement the Two Tripathi Reorts.

In addition, we attach hereto as *numbered* Exhibits white papers on LTE location technology, systems, and services ("LTE Location"). The relevance of said LTE intrinsic

[1] Note, V2G LLC, a company managed by Warren Havens, does not at this time join in these Comments. It may, however, Reply to these Comments and other Comments.

location component is initially discussed in the SkyTel Comments including its Attachment authorized by Dr. Tripathi. The Attached second of the Two Tripathi Reports explains in substantial detail LTE Location, and why the Progeny WAPS falls well short of providing an advancement (even apart from the Part 15 devices and systems issues). Thus, no advancement and viability can be ascertained, and therefore this threshold purpose test is not satisfied.

WAPS Is Not Defined *or Viable*

And There are Exiting Far Better Solutions

The Comments (other than SkyTel's) did not address the definition, nature and viability of WAPS. In this regard, Skytel submit that these other Comments missed the ***threshold issue*** in this waiver proceeding, which is that any rule waiver, to be legally sound and sustainable, must advance the underlying purpose of the waived rule or rules ("Rules") in the relevant time and market application. It is a real world exercise, as are FCC rules in radio services. See the SkyTel limited petition for reconsideration of the subject FCC decision to grant several rule waivers to Progeny ("Rule Waivers") and the related Reply, which are referenced and incorporated in full herein: The underlying purpose of M-LMS rules overall, if one reads the rulemaking orders ("Rulemaking Orders") that resulted in the rules, is wide-area location with tightly-coupled communications for Intelligent Transportation Systems ("ITS"), *where said location improves on existing location systems including those based upon GPS*. Again, that is what the full Commission discussed and determined in said Rule Orders.[2] Indeed, that is obviously why Progeny asserted (even if without proof, and without competitive comparison required for viability credibility) that its WAPS had certain accuracy and other performance metrics cited below.

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2 That is also obvious, considering the requirements of specturm use policy and Commission efficiency: If GPS radio location, and the many existing radio communications services, meet the ITS wide-area location+ coupled communication needs, then the Commission would not have engaged in very long and contested rule making resulting in establishment of a major radio service M-LMS. Aquick review of the length and depth of that rulemaking demonstrates the seriousness of this alloation of 26 MHz in 900 MHz for LMS (M-LMS and N-LMS).

Since this ***threshold issue*** is critical to this proceeding, including whether the Test and Test Report meet the conditions in the Rule waivers, SkyTel comments further on this topic herein.

As noted above, the Attached second of the Two Tripathi Reports explains in substantial detail LTE Location, and why the Progeny WAPS falls well short of providing an advancement (even apart from the Part 15 devices and systems issues). Thus, no advancement and viability can be ascertained, and therefore this threshold purpose test is not satisfied. WAPS is not a defined and viable radiolocation method. This is shown in the Two Tripathi reports.

Regarding Progeny WAPS:

- It was merely superficially sketched out and not described the Test Report (or the waiver request) in any clear and sufficient fashion for any expert in location technology and systems to undertake a serious review. Thus, no one can tell what sort of accuracy and reliability it has.

- It is not published in the professional community of wireless location: GPS- GNSS, augmentation, etc.-- their professional associations and circles (this by itself indicates it is not serious, tested, and for actual use).

- There is only one wide-area wireless location tech and system at this time, known to these circles, that is independent of GPS-GNSS, that has high accuracy and reliability, and that is in the need solutions "space" of WAPS (indoors, and in localities of satellite blockage and bad radio frequency multipath) and that is Locata.[3] See Exhibit A hereto.

  Locata has a large number of patents, proprietary tech, years of R&D, extensive professional-circles presentations and publications, testing by US Air Force, Leica Geosystems, University teams, etc. Progeny WAPS shows none of this.

- As for low- to modest- accuracy in the solutions-space Progeny WAPS targets, LTE Positioning is an existing planned tech, system and solution. See the Attached Tripathi Report and it has clear advantages over WAPS**.** *It includes multilateration* (see highlights below in the Ericcson white paper excerpts).

- There are other WAPS shortcomings, as well (see the Two Tripathi Reports).

The Test Report asserts:

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[3] SkyTel has met with Locata leaders, arranged presentations by Locata to experts at the University of California Institute of Transportation Studies, and in other ways examined Locata technology. SkyTel has no current economic stake in Locata. Its comments herein on Locata are based on its, and experts, favorable findings on Locata. SkyTel discussed Locata in its various comments in docket 06-49 regarding M-LMS.

> The NextNav solution is highly accurate. In initial testing across approximately 240 square kilometers in Santa Clara County, NextNav has achieved accuracy of better than 25 meters, 67 percent of the time.4 NextNav has also demonstrated height accuracy to within 1 to 2 meters,5 which provides a distinct benefit in multi-level structures. The NextNav link provides not only superior in-building performance, but also provides a very rapid time-to-first-fix ("TFF". A NextNav receiver can compute a position fix typically within 5 seconds. Standalone GPS can take as long as 12 minutes, while Assisted GPS ("-GPS" typically requires approximately 30 seconds.6

Initially, this (and other parts of the Test Report) do not provide proof or means to verify the above, or clear definitions of accuracy and other performance metrics, and cannot assert that since the Test does not consider many Part 15 systems and use levels, vehicle use, etc. (see SkyTel Comments and Attachment).

Progeny needs to <u>prove</u> target location accuracy under a variety of test conditions and provide comprehensive system description with extensive performance metrics (e.g., received beacon strengths and Ec/I0) for location tests. The current test report focuses on impact of specific beacon transmitter locations on certain Part 15 devices.

However, setting that aside, the reported accuracy for that percentage of time (i) is not reliable for any critical purposes, and (ii) even if that accuracy was highly reliable, it is not close to the accuracy required for critical applications, or close to currently viable solutions that are proven in the PNT community. This is shown below and in Exhibits hereto.

The following, which summarily presents the importance of highly accurate and reliable location tech, systems and services for land transportation is from the 2010 Federal Radionavigation Plan published by DOD, DHS and DOT, available from NTIA. DOT-VNTSC-RITA-08-02/DoD-4650.05, underlining added:

> **4.4.2 Land User Requirements**
> **4.4.2.1 Land Transportation Requirements**
>
> Requirements for use of PNT systems for land vehicle applications continue to evolve. Many civil land applications that use PNT systems are now commercially available. Examples of highway user applications that

are now available include in-vehicle navigation and route guidance, automatic vehicle location, automated vehicle monitoring, automated dispatch, mayday functions, and hazardous materials tracking. Other applications continue to be investigated and developed, including resource management, highway inventory control, and positive train separation. At the present time, there are many hundreds of thousands of GPS receivers in use for surface applications. Many of these are finding their way into land vehicle applications.

In order for some of the envisioned applications to be useful, they need to be coupled with a variety of space and terrestrial communication services that relay information from the vehicle to central dispatch facilities, emergency service providers, or other destinations. An example of such an application includes relaying the status of vehicle onboard systems and fuel consumption to determine allocation of fuel taxes.

The navigation accuracy, availability, and integrity needs and requirements of land modes of transportation, as well as their associated security needs and requirements (including continuity of service), have been documented in the *Air Force Space Command/Air Combat Command Operational Requirements Document (ORD) AFSPC/ACC 003-92-I/II/III for Global Positioning System* (Ref. 49). Examples of land transportation positioning and navigation system accuracy needs and requirements are shown in Table 4-7. In addition, terrain is a very important factor and must be considered in the final system analysis.

Of special interest is the concept of collision avoidance. There has been a trend to move away from infrastructure based systems towards more autonomous, vehicle based systems. It is too early in the development of these applications to determine what final form they will take, but an appropriate mix of infrastructure and vehicle based systems will likely occur that will likely incorporate PNT services.

Railroads have been conducting tests of GPS and differential GPS since the mid-1980s to determine the requirements for train and maintenance operations. In June 1995, FRA published a Report to the Committees on Appropriations, *Differential GPS: An Aid to Positive Train Control (*Ref. 50) which concluded that differential GPS could satisfy the Location Determination System requirements for the next generation positive train control systems. In November 1996, FRA convened a technical symposium on *GPS and its Applications to Railroad Operations* to continue the dialogue on accuracy, reliability, and security requirements for railroads.

Integrity solutions for land transportation functions are dependent on specific implementation schemes. Integrity values will probably range between 1 and 15 s, depending on the function. In order to meet this integrity value, GPS will most likely not be the sole source of positioning. It will be combined with map matching, dead reckoning, and other systems to form an integrated approach, ensuring sufficient accuracy, availability, and integrity of the navigation and position solution to meet user needs. Integrity needs for rail use are 5 s for most functions. Those for transit are under study and are not available at this time. The availability requirement for highways and transit is estimated as 99.7%. The availability requirement for rail is estimated as 99.9%.

Whilst USG has no statutory responsibility to provide PNT services for land PNT applications or for non-navigation uses, their existence and requirements are recognized in the Federal PNT systems planning process. Accordingly, the Government will attempt to accommodate the requirements of such users.

GPS, in conjunction with other systems, is used in land vehicle navigation. Government and industry have sponsored a number of projects to evaluate the feasibility of using existing and proposed PNT systems for land navigation. Operational tests have been completed that use in-vehicle navigation systems and electronic mapping systems to provide real-time route guidance information to drivers. GPS is used for automatic vehicle location for bus scheduling and fleet management. Operational tests are either planned or in progress to use PNT for route guidance, in-vehicle navigation, providing real-time traffic information to traffic information centers, and improving emergency response. Several transit operational tests will use automatic vehicle location for automated dispatch, vehicle rerouting, schedule adherence, and traffic signal pre-emption. Railroads and FRA have tested and continue to test GPS, NDGPS, and High Accuracy NDGPS (HA-NDGPS) as part of PTC, Track Defect Location (TDL), Automated Asset Mapping (AAM), and bridge monitoring systems. GPS and dead-reckoning/map-matching are being developed as systems that take advantage of PNT systems and at the same time improve safety and efficiency of land navigation.

4.4.2.2 Categories of Land Transportation

4.4.2.2.1 Highways

PNT applications for highway use range from precise static and dynamic survey (for project control before and during construction or creating asbuilt drawings when construction is finished) to asset tracking and route guidance. For the precise applications, geodetic accuracies, moderate integrity, and reliability are required factors. The less stringent applications have commensurately reduced accuracy, integrity, and reliability. Tables 4-7 and 4-8 identify current Highway and Trucking user requirements. Applications are being developed that rely on PNT as an input to an overall navigation solution for safety applications. Today, GPS and NDGPS, as part of CORS, provides highway transportation agencies with the critical survey grade solutions needed for building and maintaining our nation's highway.

Within the surface transportation system, Federal agencies are developing ways to improve the safety and efficiency of the nation's surface transportation system. To this end, significant effort has gone into developing approaches to address safety and efficiency, in order to reduce the loss of life and injuries that occur. GPS and its augmentations are one area that has been focused on in recent years and is the subject of ongoing research. DOT conducted ITS research to further promote the safety and reliability of travel. The National ITS Architecture defined a systems framework based on common user services delivered by transportation organizations.

[The following table is from the original, and is slightly enlarged below.]

Table 4-7 Highway User Requirements

REQUIREMENTS	MEASURES OF MINIMUM PERFORMANCE CRITERIA TO MEET REQUIREMENTS					
	ACCURACY (meters, 2 drms)	AVAILABILITY	CONTINUITY	INTEGRITY (Alert Limit)	TIME TO ALERT	COVERAGE
Navigation and route guidance	1 – 20	>95%	*	2 – 20 m	5 sec	Nationwide / Surface Coverage
Automated vehicle monitoring	0.1 – 30	>95%	*	0.2 – 30 m	5 s – 5 min	Nationwide / Surface Coverage
Automated vehicle identification	1	99.7%	*	3 m	5 sec	Nationwide / Surface Coverage
Public safety	0.1 – 30	95-99.7%	*	0.2 – 30 m	2 – 15 sec	Nationwide / Surface Coverage
Resource management	0.005 – 30	99.7%	*	0.2 – 1 m	2 – 15 sec	Nationwide / Surface Coverage
Collision avoidance	0.1	99.9%	*	0.2 m	5 sec	Nationwide / Surface Coverage
Geophysical survey	1	**	*	***	N/A	Nationwide / Surface Coverage
Geodetic control	0.01	**	*	***	N/A	Nationwide / Surface Coverage
Accident Survey	0.1 – 4	99.7%	*	0.2 – 4 m	30 sec	Nationwide / Surface Coverage
Emergency Response	0.1 – 4	99.7%	*	0.2 – 4 m	30 sec	Nationwide / Surface Coverage
Intelligent Vehicle Initiative	0.1	99.9%	*	0.2	5 sec	Nationwide / Surface Coverage

* Continuity applies to phases of operations. For highway applications, this has not been defined.
** In these instances, availability of a real-time solution is not needed, but is beneficial.
*** This is typically done using post-processing techniques. While integrity of the data is important, it is not used to directly support safety and can be provided after data is collected

This research into developing applications that improve the safety and efficiency of the surface transportation system are the current focus for determining requirements that need to be established for PNT systems. Ongoing efforts are examining what is currently available and determining what levels of accuracy, integrity, and availability are required. Since these systems integrate the solution from GPS, DGPS, inertial systems, mapmatching systems, wheel rotation counters, localized beacons, etc., defining the required parameters is dependent on the level of dependence on each these subsystems.

For many of the safety systems, submeter accuracies have been identified as needed to assist in improving safety and efficiency. Combined with other subsystems in the vehicle and the infrastructure, accuracies in range of 10 cm horizontal (95%) have been suggested. Ongoing research will determine this accuracy more definitively while also identifying integrity and availability levels.

* * * *

4.4.2.2.2 Transit

Transit systems also benefit from the same PNT-based technologies. Automatic vehicle location techniques assist in fleet management, scheduling, real-time customer information, and emergency assistance. In addition, random route transit operations will benefit from route guidance in rural and low-density areas. Also, services such as automated transit stop annunciation are being implemented. Benefits of radiolocation for public transit, when implemented with a two-way communications system, have been proven in a number of deployments across the U.S. Improvements in on-time performance, efficiency of fleet utilization, and response to emergencies have all been documented. Currently, there are over 60,000 transit vehicles that employ automatic vehicle location using GPS for these fleet management functions and the deployment is continuing to spread.

Currently, the integrity requirements are unknown for transit PNT applications, but user requirements are generally similar to Highway User Requirements. Table 4-7 may be used as a reference for transit. As the transit research starts to define current applications and develop newer applications for the safety and mobility that integrate GPS, DGPS, and other PNT solutions, specific requirements for accuracy, integrity and availability have to be established for the transit PNT systems. Ongoing and future research will also need to coordinate with FHWA and FRA to define and enhance these requirements.

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Appendix A

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Types of Accuracy

Specifications of PNT system accuracy generally refer to one or more of the following definitions:

• Predictable accuracy: The accuracy of a PNT system's position solution with respect to the charted solution. Both the position solution and the chart must be based upon the same geodetic datum.

Further, Ex Parte, Supplements

SkyTel may submit ex parte supplemental materials in further support of its Comments and these Reply Comments, from relevant publications and authorities.

Conclusions

For reasons given herein and in the preceding SkyTel Comments, including the referenced and incorporated Two Tripathi Reports, the Progeny Test and Test Report failed both the threshold purpose and the execution.

Highly accurate and reliable location, with well integrated communications, is the sine qua non of M-LMS, is possible, and is increasingly and greatly needed. Progeny is pursuing something else by design, and what that it is keeps hidden.

The condition in the waivers grant has not been satisfied, and the valuable M-LMS spectrum in the Progeny licenses must be retained for the Commission's fully justified purpose of M-LMS, the nations only and critical wide-area ITS radio service.

This can be integrated with ITS DSRC, and can also use Part 15 mode (see SkyTel Comments on Progeny Test), and can co-exist properly with local-area Part 15 device systems and deployments, and operate in synergistic fashion.

There are compelling public-policy, technical and economic reasons for this conclusion amply presented by SkyTel in this proceeding and in dozens of comments (including with other leading experts and associations) in the M-LMS NPRM docket 06-49.

[Execution on next page.]

Respectfully submitted, March 30, 2012,

Skybridge Spectrum Foundation, by
[Filed electronically. Signature on file.]
Warren Havens, President

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Ericsson White Paper[4]

284 23-3155 Uen | September 2011

Emphasis added below. The below are excerpts. See attached full copy as an Exhibit.

* * * *

LTE Positioning Architecture, Protocol and Methods

Decentralizing the radio-access network (RAN) architecture and minimizing the number of node levels are key characteristics of the design philosophy behind LTE. In addition to this, 3GPP decided that positioning architecture should be transparent to the underlying radio network. As a result, LTE positioning functionality is distributed across LTE radio nodes, eNodeBs, and the positioning node. The eNodeBs, for example, ensure proper configuration of positioning reference signals, provide information to the Enhanced Serving Mobile Location Center (E-SMLC), enable UE inter-frequency measurements if necessary, and provide network-based measurements on request from the E-SMLC.

The positioning node determines which positioning method to use, builds up and provides assistance data to facilitate calculating measurements, collects the necessary measurements, works out the position, and communicates the result to the requesting client.

Operators typically require support for positioning over both the control and user planes. In the control plane, a positioning request is always sent by the Mobility Management Entity (MME) to the E-SMLC, and the delivery of a response – including positioning data, user authorization and charging information – is controlled by the Gateway Mobile Location Center (GMLC). In the user plane, positioning information is exchanged over data channels using the Secure User Plane Location (SUPL) protocol in the application layer.

ARCHITECTURE AND PROTOCOLS

LTE positioning architecture contains three key network elements: the LCS client, LCS target and LCS server. The LCS server is a physical or logical entity that manages positioning for an LCS target device. It collects measurements and other location information, assists the UE in calculating measurements when necessary, and estimates the LCS target location. An LCS client is a software and/or hardware entity that interacts with an LCS server to obtain location information for LCS targets and may reside in the LCS target. An LCS client sends a request to the LCS server to obtain location information; the LCS server processes the request and sends the positioning result and, optionally, a velocity estimate back to the LCS client. A positioning request can originate from either the UE or the network.

LTE operates two positioning protocols via the radio network: LTE Positioning Protocol (LPP) and LPP Annex (LPPa). LPP is a pointto-point protocol for communication between an LCS server and an LCS target device, and is used to positi on the device. LPP can be used both in the user plane and control plane, and multiple LPP procedures are allowed in series and/or in

[4] Copy at: http://www.ericsson.com/res/docs/whitepapers/WP-LTE-positioning.pdf

parallel, reducing latency. LPPa is a communication protocol between an eNodeB and an LCS server for control-plane positioning – although it can assist user-plane positioning by querying eNodeBs for information and measurements. The SUPL protocol is used as a transport for LPP in the user plane.

Figure 2 [5]illustrates LTE's high-level positioning architecture, where the LCS target is a terminal, and the LCS server is an E-SMLC or an SLP. The control-plane positioning protocols with E-SMLC as the terminating point are shown in blue, and the user plane positioning protocol chain in red.

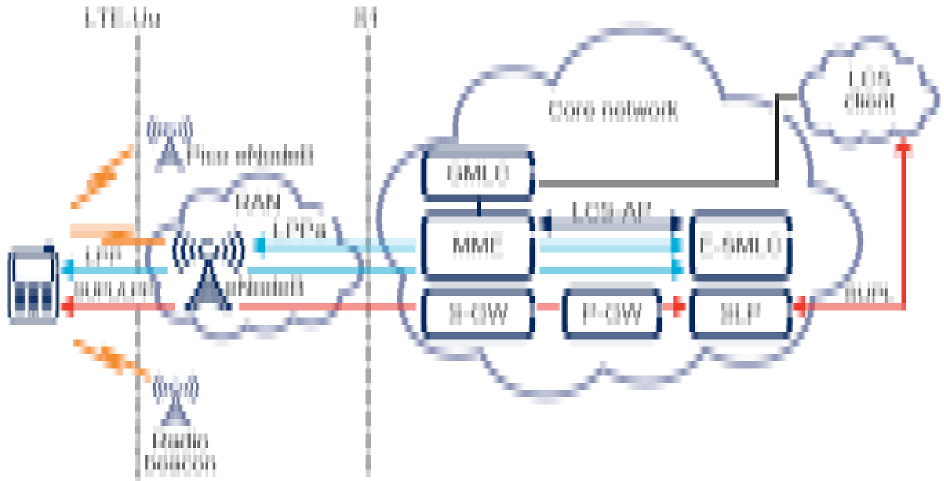

Figure 2: Positioning architecture in LTE Release 9/Release 10

Deploying additional positioning architecture elements, such as radio beacons, can enhance the performance of individual positioning methods. Deploying extra radio beacons and, for example, using proximity location techniques is a cost-efficient solution that can significantly improve positioning performance both indoors and outdoors.

POSITIONING METHODS

To meet the demands created by LBS, LTE networks support a range of complementary positioning methods. The basic method – Cell ID (CID) – utilizes cellular system knowledge about the serving cell of a specific user; the user location area is thus associated with the serving CID. Support for this method has been mandatory since Release 8, and the following methods became available with Release 9:

- Enhanced Cell ID (E-CID) – UE-assisted and network-based methods that utilize CIDs, RF measurements from multiple cells, timing advance, and Angle of Arrival (AoA) measurements
- **OTDOA** – UE-assisted method based on reference signal time difference (RSTD) measurements conducted on downlink positioning reference signals received from multiple locations, where the user location is calculated **by multilateration**
- A-GNSS – UE-based and UE-assisted methods that use satellite signal measurements retrieved by systems such as Galileo (Europe) and GPS (US). LTE supports positioning with existing satellite systems and will develop as new satellite systems become available.

[5] This graphic as embedded is blurred. See attached full copy of this White Paper for a clear graphic.

The following commonly known methods do not require additional standardization and are also included in LTE Release 9:

- RF fingerprinting, a method of finding a user position by mapping RF measurements obtained from the UE onto an RF map, where the map is typically based on detailed RF predictions or site surveying results
- AECID [3,5], a method that enhances the performance of RF fingerprinting by extending the number of radio properties that are used, where at least CIDs, timing advance, RSTD, and AoA may be used in addition to received signal strengths, and where the corresponding databases are automatically built up by collecting high-precision OTDOA and A-GNSS positions, tagged with measured radio properties
- hybrid positioning, a technique that combines measurements used by different positioning methods and/or results delivered by different methods.

Uplink TDOA (UTDOA), an uplink alternative method to OTDOA, is being standardized for Release 11. UTDOA utilizes uplink time of arrival (ToA) or TDOA measurements performed at multiple receiving points. Measurements will be based on Sounding Reference Signals (SRSs). For some environments, positioning based on measurements of radio signals can be challenging. Alternative methods, such as enhanced proximity location, can be applied as complements to CID-based methods to improve positioning results. A proximity method may, for example, utilize knowledge about the set of detected networks or radio devices. As civic address information associated with a cell or network node is both comprehensible by a person and the native format for PSAPs, a proximity method may use this information instead of geographical coordinates.

CID is the fastest available measurement-free positioning method that relies on the cell ID of the serving cell – typically available information – and the location associated with that cell, but its accuracy depends on the size of the serving cell. A-GNSS, including A-GPS, is the most accurate positioning method in satellite-friendly environments. The most accurate terrestrial method is OTDOA, which is based on downlink measurements of positioning reference signals transmitted by radio nodes such as eNodeBs or beacon devices. OTDOA and A-GNSS provide highly accurate positioning in most parts of a cellular network and for most typical environments. UTDOA performance may approach that of OTDOA in some deployment scenarios that are not UL-coverage-limited, assuming the use of enhanced UL receivers. **To improve positioning in challenging radio environments, these methods can be complemented, for example, with hybrid positioning, proximity location and new positioning methods in the middle accuracy range, including AoA, RF fingerprinting and AECID. Note that the AECID method utilizes a wider set of measurements than the RF fingerprinting method – including, for example, timing measurements – meaning that AECID is significantly less subject to environment limitations**. In the future, as networks become denser, the role of proximity methods will become important.

* * * *

CONCLUSION

LTE technology enhances positioning performance, provides flexibility for applications and creates new business opportunities for location-based applications and services. **Because no single positioning method works well in all environments, new-generation positioning systems must have integrated solutions that combine a wide range of complementary positioning methods and techniques together with the ability to learn about and adapt to the radio environment**. **Indeed, the need for multi-standard positioning solutions is obvious in a world where such a large variety of radio access and positioning standards coexist**. However, there remains a pressing need to align the position-reporting formats used by cellular networks and emergency systems if emergency services are to benefit from the degree of accuracy their line of work demands, while also remaining cost- and resource-efficient.

[The paper containing the above excerpts is attached hereto as an Exhibit. Other LTE Positioning white papers or presentations are also attached.]